

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

re Application of

Atty. Docket

WALID ALI

US 010194

Serial No.: 09/938,377

Group Art Unit: 2661

Filed: AUGUST 24, 2001

Title: AN APPARATUS AND METHOD FOR COMBINING RANDOM SET OF VIDEO FEATURES IN A NON-LINEAR SCHEME TO BEST DESCRIBE PERCEPTUAL QUALITY OF VIDEO SEQUENCES USING HEURISTIC SEARCH METHODOLOGY

Commissioner for Patents Washington, D.C. 20231

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LETTER TO OFFICIAL DRAFTSMAN

Technology Center 2600

Sir:

Enclosed are (4) four sheets of formal drawings for filing in the above-identified application.

Respectfully submitted,

Attorney

(914) 333-9631

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited this date with the United States Postal Service as first-class mail in an envelope addressed to:

COMMISSIONER OF PATENTS AND TRADEMARKS Washington, D.C. 20231

SEARCH METHODOLOGY Contact: Russell Gross (914) 333-9631 1/4 START 100 RECEIVING A VIDEO SEQUENCE FOR IMAGE QUALITY EVALUATION; PROVIDING AN OBJECTIVE METRIC IMAGE QUALITY CONTROLLER 110 COMPRISING A RANDOM SET OF METRICS RANGING FROM M₁ TO M_n WITHOUT CROSS CORRELATION INFORMATION; 120 -APPLYING SAID EACH ONE METRIC OF SAID SET METRICS INDIVIDUALLY TO SAID VIDEO SEQUENCE: SO THAT SAID EACH ONE METRIC OF SAID RANDOM SET OF METRICS PROVIDES AN INDIVIDUAL OBJECTIVE SCORING VALUE OF SAID VIDEO SEQUENCE RANGING FROM x_1 TO x_n DETERMINING A PLURALITY OF SETS OF WEIGHTS (W₁ TO W_n) WHICH CORRELATE TO PREDETERMINED SUBJECTIVE EVALUATIONS OF IMAGE QUALITY FOR A PREDETERMINED PLURALITY OF VIDEO SEQUENCES (n) 130 WEIGHTING BY SAID EACH ONE SET OF WEGHTS EACH 140 INDIVIDUAL OBJECTIVE SCORING VALUE X₁ TO X_n 150 ADDING THE WEIGHTED INDIVIDUAL OBJECTIVE SCORING VALUES OF SAID RANDOM SET OF METRICS INTO A SINGLE OBJECTIVE EVALUATION F, WHEREIN EACH WEIGHTED INDIVIDUAL SCORING VALUE FROM STEP (140) IS MULTIPLIED BY EACH INDIVIDUAL OBJECTIVE SCORING VALUE X₁ TO X₀ FROM STEP (120); 160 CALCULATING A CORRELATION FACTOR R TO PROVIDE A CORRELATION VALUE FOR THE OBJECTIVE EVALUATION F AND THE PLURALITY OF VIDEO SEQUENCES (n);

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FIG. 1A

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REPEATING STEPS (140), (150) AND (160) FOR EACH SET OF WEIGHTS PROVIDED IN STEP (130) TO DETERMINE A PLULARITY OF CORRELATION FACTORS R;

180 ~

RANKING SAID PLURALITY OF CORRELATION FACTORS R, WHEREIN A PARTICULAR CORRELATION FACTOR OF SAID PLURALITY OF CORRELATION FACTORS HAVING A PARTICULAR CORRELATION VALUE CLOSEST TO 1 REPRESENTS A BEST RANKING OF THE RESPECTIVE COMBINED METRICS IN STEP (140) FOR EACH SET OF WEIGHTS;

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PROVIDING IMAGE QUALITY INFORMATION TO AT LEAST ONE OF A SYSTEM OPTIMIZER AND THE VIDEO PROCESSING MODULE AS TO THE BEST RANKING OF THE RESPECTIVE COMBINED METRICS OBTAINED IN STEP (i) TO PROVIDE A BEST PERCEPTUAL IMAGE QUALITY

FIG. 1B

WHEN A PREDETERMINED NUMBER OF SETS OF METRICS = n, THE QUADRATIC MODEL TO OBTAIN THE OBJECTIVE EVALUATION F IS:

$$\mathsf{F} = (\sum_{i=1}^n \mathsf{w}_i \mathsf{x}_i)^2, \, \mathsf{WHEREIN} \, \text{``n''} \, \mathsf{IS} \, \mathsf{A} \, \mathsf{NON\text{-}ZERO} \, \mathsf{VALUE}.$$

FIG. 1C

WHEN A NUMBER OF THE SET OF METRICS = 4, THEN THE QUADRATIC MODEL TO OBTAIN THE OBJECTIVE EVALUATION F IS:

$$F = W_{1}X_{1} + W_{2}X_{2} + W_{3}X_{3} + W_{4}X_{4} + W_{5}X_{1}X_{2} + W_{6}X_{1}X_{3} + W_{7}X_{1}X_{4}$$

$$+ W_{8}X_{2}X_{3} + W_{9}X_{2}X_{4} + W_{10}X_{3}X_{4}$$

FIG. 1D

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SELECTING A BEST OF WEIGHTS FROM THE PLURALITY OF SETS OF WEIGHTS PROVIDED IN STEP (130), SAID BEST SET OF WEIGHTS BEING HEURISTICALLY DETERMINED BY A GENETIC ALGORITHM THAT INCREASES DYNAMICALLY A SIZE OF THE ASSIGNED RANGE OF SAID EACH ONE SET OF WEIGHTS PROVIDED IN STEP (130).

FIG. 1E

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SELECTING A BEST OF WEIGHTS FROM THE PLURALITY OF SETS OF WEIGHTS PROVIDED IN STEP (130), SAID BEST SET OF WEIGHTS BEING HEURISTICALLY DETERMINED BY A GENETIC ALGORITHM THAT ENABLES FINDING THE BEST SOLUTION THAT MAXIMIZES THE CORRELATION FACTOR R OF THE OVERALL OBJECTIVE IMAGE QUALITY F WITH THE SUBJECTIVE EVALUATION WITHOUT THE NEED TO CARRY OUT AN EXHAUSTIVE SEARCH TO FIND THE BEST SET OF WEIGHTS.

FIG. 1F

CALCULATING OF THE CORRELATION FACTOR R IN STEP (160) BY USING A SPEARMAN RANK ORDER COMPRISING THE FOLLOWING EQUATION:

$$R = 1 - \frac{6^*(X-Y)^t (X-Y)}{k(k^2 - 1)}$$

WHEREIN X IS EQUAL TO A VECTOR OF RANKED k OBJECTIVE VALUES FOR THE k SEQUENCES (k*1), AND

Y IS EQUAL TO A VECTOR OF RANKED & SUBJECTIVE EVALUATION FOR THE & SEQUENCES (k*1).

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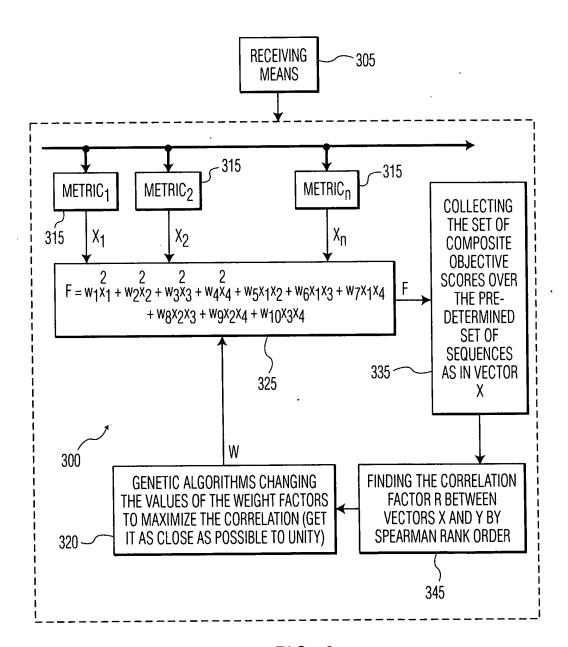


FIG. 3